IOP HRDL Processor Software Requirements

Fluids and Combustion Facility Common Subsystems

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PREFACE

The National Aeronautics and Space Administration (NASA) is developing a modular, multi-user experimentation facility for conducting fluid physics and combustion science experiments in the microgravity environment of the International Space Station (ISS). This facility, called the Fluids and Combustion Facility (FCF), consists of three test platforms: the Fluids Integrated Rack (FIR), the Combustion Integrated Rack (CIR), and the Shared Accommodations Rack (SAR). This document describes the requirements for the IOP HRDL Processor, one of four processors in the IOP (Input Output Processor). The IOP is the rack controller and is present in all three racks, the CIR, FIR, and SAR.

IOP HRDL PROCESSOR SOFTWARE REQUIREMENTS FOR THE FLUIDS AND COMBUSTION FACILITY COMMON SUBSYSTEMS

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IOP HRDL PROCESSOR SOFTWARE REQUIREMENTS FOR THE FLUIDS AND COMBUSTION FACILITY COMMON SUBSYSTEMS

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REVISION PAGE
IOP HRDL PROCESSOR SOFTWARE REQUIREMENTS

Revision	Date	Description of Change or ECO's Incorporated	Verification and Date
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1.0 SCOPE

1.1 IDENTIFICATION

This document establishes the software performance and software qualification requirements for the IOP (Input/Output Package) HRDL Processor CSCI in both its launch and its on-orbit configuration. The IOP is part of the United States Laboratory Module (US Lab) Fluids and Combustion Facility (FCF) of the International Space Station (ISS).

1.2 SYSTEM OVERVIEW

The purpose of the IOP is to provide command and control functions along with the collection and monitoring of all FCF health and status data. The IOP manages timing functions within the rack. The IOP provides the ability for communications between all processors in the FCF. Storage of all science data is accommodated along with the ability to downlink and uplink data and commands through the ISS communications interfaces. The ability for communications between all FCF racks is provided through the IOP. [3.1.1, FCF-SPEC-xxx]

1.3 DOCUMENT OVERVIEW

This document is meant to capture the requirements that are constrained upon the IOP HRDL Processor as it relates to the CIR, FIR, and SAR.

2.0 REFERENCED DOCUMENTS

This section discusses all documents, including both government and non-government documents referenced in this specification

2.1 Order of Precedence for Documents

In the event of a conflict between this document and other documents referenced herein, the requirements of this document shall apply. In the event of a conflict between this document and the contract, the contractual requirements shall take precedence over this document. All documents used, applicable or referenced, are to be the issues defined in the Configuration Management (CM) contract baseline. All document changes, issued after baseline establishment, shall be reviewed for impact on scope of work. If a change to an applicable document is determined to be effective, and contractually approved for implementation, the revision status will be updated in the CM contract baseline. The contract revision status of all applicable documents is available by accessing the CM database. Nothing in this document supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.2 GOVERNMENT Documents

301.0-B-2	
701.0-B-2	
D684-10056-01	
SSP 41175-02	Software ICD Part 1 Station Management and Control to ISS Book 2, General Interface Software Interfaces Requirement
SSP 50184	
SSP 52050	Software Interface Control Document Part 1, International Standard Payload Rack to International Space Station
SSP 53013	
SSP 57000	
SSP 57001	
SSP 57002	Payload Software Interface Control Document Template
SSP 57217	
SSP 57218	
SSP 57219	

SSP 57317

SSP 57318

SSP 57319

Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

2.3 NON-GOVERNMENT DOCUMENTS

The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of a conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

FCF-DOC-002	FCF Project Science Requirements Envelope Document
FCF-ICD-0076	FCF Software Interface Control Document
FCF-REQ-0063	FCF Software Requirements Document
FCF-SPEC-0001	System Specification: International Space Station Fluids and Combustion Facility
FCF-SPEC-0012	
FCF-SPEC-xxx	Critical Item Product Specification: Input/Output Package Fluids and Combustion Facility

3.0 REQUIREMENTS

A system level use-case diagram shall be included here, TBD.

The requirements that form this document are found in FCF-SPEC-0001 in association with FCF-DOC-002, FCF-SPEC-xxx and SSP 57000.

3.1 REQUIRED STATES AND MODES

Requirements correlation to states and modes, TBD

System State diagram shall be included here, TBD.

Requirement Id	Requirement Description
10	The IOP shall manage modes and states control. [Derived] The following states with their subset of corresponding modes are as follows. 1. Nominal a. Pre-test b. Test c. Post-Test 2. Off-Nominal a. Malfunction b. Maintenance

3.2 CSCI CAPABILITY REQUIREMENTS

3.2.1 Data Management

Requirement Id	Requirement Description
10	The IOP HRDL Processor CSCI shall record and time-tag all data streams (including video) that are acquired from the rack subsystems, per the requirements of FCF-DOC-002, Section 2.4.2 (for the FIR) and 3.4 (CIR). [3.7.1.3.1-D, 3.7.2.3.1-D, 3.7.3.3.1-I, FCF-SPEC-0001]
20	The IOP HRDL Processor CSCI shall be capable of transferring data to the ISS for communication to the ground for use by the payload equipment and the FCF ground crews and for data archiving purposes. [3.2.1.1.4-E, FCF-SPEC-0001]
30	The IOP HRDL Processor CSCI shall be capable of acquiring payload equipment data streams per the requirements of FCF-DOC-002, Section 3.4 (for the CIR), 2.4.1 (for the FIR). [3.7.1.3.1-C, 3.7.2.3.1-C, FCF-SPEC-0001]
40	The IOP HRDL Processor CSCI shall be capable of accommodating payload software per the requirements of FCF-DOC-002, Section 2.4.3. [3.7.1.3.1-E, 3.7.2.3.1-E, FCF-SPEC-0001]
50	The SAR shall be capable of electronically transferring all data generated in the Flight Segment to ISS for transfer to the ground. [3.7.3.3.3-D, FCF-SPEC-0001]
60	The SAR shall be capable of transferring all data generated in the Flight Segment to portable media for return to the ground via the Space Shuttle or other ISS provided transportation. . [3.7.3.3.3-G, FCF-SPEC-0001]

3.2.2 Reconfiguration and Maintenance

Requirement Id	Requirement Description
10	The IOP HRDL Processor CSCI software shall be modifiable via the ISS communication network. [3.2.1.13.2-A FCF-SPEC-xxx] [3.4.2-A, FCF-SPEC-0001]
20	The design of the Flight Segment shall not preclude the operation of Flight Segment rack(s) while maintenance is being performed on another Flight Segment rack(s). Degraded microgravity environment and loss of data acquisition/processing functions shared between racks is permissible. [3.2.4.8, FCF-SPEC-0001]
30	The design of the FCF System shall accommodate the incorporation of upgrades, over its 15-year lifetime, to any ORU, including but not limited to, communication buses and computer hardware, firmware, and peripherals. [3.2.4.10, FCF-SPEC-0001]
40	The IOP HRDL Processor CSCI shall provide for maintenance of the IOP to keep it within the performance parameters specified within this document, for maintenance/replacement of limited life items and for the replacement of ORUs that have failed or are operating in an out-of-tolerance condition.

Requirement Id	Requirement Description
	[3.7.1.3.6-B, 3.7.2.3.6-B, 3.7.3.3.7-B, FCF-SPEC-0001]
50	The IOP HRDL Processor CSCI shall support the reconfiguration necessary to support and accommodate payload equipment systems manifested in the FCF. This includes both hardware and software reconfiguration. [3.7.1.3.7-A, 3.7.2.3.7-A, 3.7.3.3.8-A, FCF-SPEC-0001]
60	The IOP HRDL Processor shall be capable of being reconfigured without impacting the operations of the CIR, FIR or SAR, except for possible microgravity disturbances. [3.7.1.3.7-B, 3.7.2.3.7-B, 3.7.3.3.8-B, FCF-SPEC-0001]
70	All such planned IOP HRDL Processor reconfiguration activities shall be capable of being accomplished with the rack in its installed position. [3.7.1.3.7-C, 3.7.2.3.7-C, 3.7.3.3.8-C,FCF-SPEC-0001]

3.2.3 PI Related

Requirement Id	Requirement Description
10	The IOP HRDL Processor CSCI, shall be designed to support test point durations of no less than 9,000 sec in accordance with the combustion basis experiments as specified in FCF-DOC-002. [3.2.1.3.1, FCF-SPEC-xxx]
20	The IOP HRDL Processor CSCI shall be designed to support test point durations of no less than TBD sec in accordance with the fluid physics basis experiments as specified in FCF-DOC-002. [3.2.1.3.2, FCF-SPEC-xxx]
30	The IOP HRDL Processor CSCI shall be designed to accommodate no less than 80 test points in accordance with the combustion [Specified where??] and 10 - 500 test points in accordance with the fluids basis experiments as specified in 2.2.3, FCF-DOC-002. [3.2.1.4.2, FCF-SPEC-xxx]

3.3 CSCI EXTERNAL INTERFACE REQUIREMENTS

Requirement Id	Requirement Description
10	The IOP shall verify the integrity of all files it transmits and receives. [3.2.1.13.1-B, FCF-SPEC-xxx] [3.4.1-B&C, FCF-SPEC-0001]

3.3.1 Interface Identification and Diagrams

A system architecture diagram shall be included, TBD.

3.3.1.1 ISS Fiber Optic High Rate Data Link Interface

The High Rate Data Link telemetry interface interfaces with the ISS HRDL. The interface characteristics imposed upon the High Rate Data Link are by the Software Interface Control Document Part 1, International Standard Payload Rack to International Space Station, SSP 52050.

3.3.1.2 IOP Main Processor 100BaseT Ethernet Interface

The IOP Main Processor Ethernet command and telemetry interface interfaces with the IOP Main Processor CSCI.

3.3.2 Interface Requirements

3.3.2.1 ISS Fiber Optic High Rate Data Link Interface

3.3.2.1.1 Commands and Telemetry

Requirement Id	Requirement Description
10	The IOP HRDL CSCI shall receive the segmented time code by a broadcast message from the IOP Main Processor CSCI.
20	The IOP shall provide for priority commands. [Derived]

3.3.2.1.2 Data Formats

Requirement Id	Requirement Description
10	The IOP shall use the word/byte notations as specified in paragraph 3.1.1, Notations in SSP 52050. Section [3.2.1.13.1.1.1, FCF-SPEC-xxx]
20	The IOP shall use the data types as specified in paragraph 3.2.1 and subsections, Data Formats in SSP 52050. [3.2.1.13.1.1.2, FCF-SPEC-xxx]
30	IOP data that will be transmitted to the ground through the ISS resources shall be formatted in CCSDS data packets. [3.2.1.13.1.1.4-A, FCF-SPEC-xxx]
40	IOP data that will be transmitted to the Payload MDM through ISS resources shall be formatted in CCSDS data packets. [3.2.1.13.1.1.4-C, FCF-SPEC-xxx]
50	IOP data packets shall be developed in accordance with paragraph 3.1.3 of SSP 52050. IOP CCSDS data packets consist of a primary header and a secondary header followed by the data field. [3.2.1.13.1.1.4.1, FCF-SPEC-xxx]
60	The IOP shall develop a CCSDS primary header in accordance with paragraph 3.1.3.1 CCSDS Primary Header Format of SSP 52050. [3.2.1.13.1.1.4.1.1, FCF-SPEC-xxx]
70	The IOP shall develop a CCSDS secondary header immediately following the CCSDS primary header. The CCSDS secondary header shall be developed in accordance with paragraph 3.1.3.2, CCSDS Secondary Header Format of SSP 52050. [3.2.1.13.1.1.4.1.2A+B, FCF-SPEC-xxx]
80	The IOP CCSDS data field shall contain the IOP data from the transmitting application to the receiving application, and the CCSDS checksum in accordance with paragraph 3.1 and subparagraphs, Data Formats and Standards, of SSP 52050. [3.2.1.13.1.1.4.1.3, FCF-SPEC-xxx]
90	The IOP bitstream data shall be developed in accordance with paragraph 2.3.2.3, Bitstream Service of CCSDS 701.0–B–2. [3.2.1.13.1.1.4.1.4, FCF-SPEC-xxx]
100	The IOP shall use CCSDS Application Process Identification (APID) for

Requirement Id	Requirement Description
	routing data packets as described in paragraph 3.3.2.1.3, APID Routing, of SSP 41175–2. The format of APIDs is shown in Table 3.3.2.1.1–1, CCSDS Primary Header Field Definitions, of SSP 41175–2. [3.2.1.13.1.1.4.1.5, FCF-SPEC-xxx]
110	IOP shall use CCSDS Unsegmented Time Code (CUC) in the secondary header as specified in paragraph 2.2, CCSDS Unsegmented Time Code (CUC), of CCSDS 301.0–B–2. [3.2.1.13.1.1.4.2.1, FCF-SPEC-xxx]

3.3.2.1.3 Data Link

Requirement Id	Requirement Description
10	The IOP shall be capable of interfacing with the ISS to allow a minimum of on-orbit data transfer in support of test point durations of no less than 9000 seconds and shall accommodate no less than 80 test points as specified in 3.2.1.19 and 3.2.1.20 of FCF-SPEC-0012. [3.2.1.9, FCF-SPEC-xxx]
20	The IOP data transmission on High Rate Data Link (HRDL) shall use the data transmission order in accordance with paragraph 1.6, Bit Numbering Convention and Nomenclature in CCSDS 701.0–B–2. . [3.2.1.13.1.1.3-C, FCF-SPEC-xxx]
30	The IOP shall use the HRFM common protocols in accordance with paragraph 3.3.2, HRFM Protocols of SSP 50184. [3.2.1.13.1.1.7, FCF-SPEC-xxx]
40	The IOP shall be designed to transmit data on the HRDL with adjustable data rates in between 0.5 Mbps to 95 Mbps. [3.2.1.13.1.1.7.1.1-A, FCF-SPEC-xxx]
50	The IOP HRDL data rate shall be adjustable in increments of 0.5 Mbps. [3.2.1.13.1.1.7.1.1-B, FCF-SPEC-xxx]
60	Transmitted data shall be designed to be ”evenly parsed” in accordance with paragraph 3.3.1.3.2, Evenly Parsed Data of SSP 50184. [3.2.1.13.1.1.7.1.1-C, FCF-SPEC-xxx]
70	The HRDL is a shared resource on the International Space Station. The HRDL data is sent to the ground through the HRFM. When a payload has the entire HRFM capacity assigned to that payload, the Maximum HRDL Data Rate is approximately 43 Mbps. Under normal conditions the Payload shares the 43 Mbps with 11 other data sources. The actual HRDL data rate designed into the Payload is subject to planning. [3.2.1.13.1.1.7.1.1-1, FCF-SPEC-xxx]
80	The IOP HRDL maximum designed data rate is subject to planning. [3.2.1.13.1.1.7.1.1-2, FCF-SPEC-xxx]

Requirement Id	Requirement Description
90	The IOP is not required to implement every possible increment in the negotiated range. For example, an integrated rack may choose to implement 0.5, 1.0, 2.0, 4.0, 8.0, and 16.0 Mbps for a planned range of 0.5 to 16.0 Mbps. [3.2.1.13.1.1.7.1.1-3, FCF-SPEC-xxx]
100	The data rate tolerance is TBD. [3.2.1.13.1.1.7.1.1-4, FCF-SPEC-xxx]
110	The IOP may use any HRDL data rate desired in a multi–location payload where the source payload and the destination payload for the HRDL data is developed by one payload project. [3.2.1.13.1.1.7.1.1-5, FCF-SPEC-xxx]
120	The IOP shall encode the HRDL data in accordance with paragraph 3.1.3, Encoding, including both 3.1.3.1, Data and Symbol Encoding and Table 3.1.3.1–1, 4B/5B Non Return to Zero Event (NRZI) Encoding, and 3.1.3.2 Special Symbol Encoding of SSP 50184. [3.2.1.13.1.1.7.2, FCF-SPEC-xxx]

3.3.2.2 IOP Main Processor 100BaseT Ethernet Interface

Requirement Id	Requirement Description
10	The interface characteristics imposed upon the IOP Main Processor Ethernet Interface are found in the Software ICD, FCF-ICD-0076.

3.4 CSCI INTERNAL INTERFACE REQUIREMENTS

A System Architecture Diagram shall be included, TBD.

Requirement Id	Requirement Description
10	The IOP HRDL Processor CSCI shall handle commands destined for internal IOP HRDL Processor entities. [Derived]
20	The IOP HRDL Processor CSCI shall provide for priority commands. [Derived]

3.5 CSCI INTERNAL DATA REQUIREMENTS

Requirement Id	Requirement Description
10	The FCF System shall retain all data until commands are received from the FCF ground operations team indicating what data can be deleted or over-written. This will assure that GRCTSC data storage and/or data archiving systems have captured all necessary data before deleting the associated raw data. [3.2.1.1.4-F, FCF-SPEC-0001]
20	The IOP HRDL CSCI shall report to the ground on the following off-nominal events: [Derived] a. failure to complete initialization b. command failed validation c. BIT status indicating failure d. High Rate Data Link (HRDL) transmission errors e. data, raw or derived, out of limits

3.6 ADAPTATION REQUIREMENTS

Refer to FCF Software Requirements Document, FCF-REQ-0063. Section 3.6 Adaptation Requirements.

3.7 SAFETY REQUIREMENTS

Refer to FCF Software Requirements Document, FCF-REQ-0063. Section 3.7 Safety Requirements.

3.8 SECURITY AND PRIVACY REQUIREMENTS

Requirement Id	Requirement Description
10	The IOP HRDL Processor CSCI shall assure that there is protection in place to prevent unauthorized commands from being sent to the IOP HRDL Processor CSCI, unauthorized access to proprietary data generated by the FCF, and unauthorized changes to IOP electronic files. [3.3.12, FCF-SPEC-xxx]

3.9 CSCI ENVIRONMENT REQUIREMENTS

Requirement Id	Requirement Description
10	The IOP shall operate on a DY4-177 (power-pc architecture), single Board Computer, running VxWorks operating system.

3.10 COMPUTER RESOURCE REQUIREMENTS

The IOP HRDL Processor shall make use of ISS Program provided support equipment: a Payload Rack Checkout Unit (PRCU) to verify its ISS HRDL interface prior to launch and a Suitcase Test Environment for Payloads (STEP) to support FCF HRDL avionics development. [3.1.6.1, FCF-SPEC-0001]

3.10.1 Computer Hardware Requirements

Currently the IOP HRDL Processor consists of:

Requirement Id	Requirement Description
10	The IOP HRDL Processor card is currently a Boeing supplied card that provides a 100 Mbit/s fiber optic transmitter interface to the ISS HRDL system. In addition, the card has a 10BaseT Ethernet interface and an 8 Bit SCSI 2 interface.
20	Two 73 Gbyte hard drives are connected to the HRDL SCSI bus. These hard drives and controllers are all on the same bus allowing full access to FCF data from either the IOP Main Processor or IOP HRDL Processor. The hard drives are housed in removable carriers so that each hard drive can be individually removed from the front of the IOP. This allows easy removal of the hard drives to return data to earth or for replacement of a hard drive without removing the IOP.

3.10.2 Computer Hardware Resource Utilization Requirements

Requirement Id	Requirement Description
10	Prior to SAR deployment, each computer communication bus (1553, ethernet, etc) shall be designed so that the transfer of all data required to perform the basis experiments as specified in FCF-DOC-002, does not exceed 55% of the bus bandwidth over any ten second period. [3.2.1.13.2-D, FCF-SPEC-xxx]
20	After SAR deployment, each computer communication bus (1553, ethernet, etc) shall be designed so that the transfer of all data required to perform the basis experiments as specified in FCF-DOC-002, does not exceed 60% of the bus bandwidth over any ten second period. [3.2.1.13.2-E, FCF-SPEC-xxx]
30	Prior to SAR deployment, the volatile memory of all IOP single board computers and associated circuit boards shall be sized so the information required to perform the basis experiments as specified in FCF-DOC-002, does not exceed 55% of the bytes available and 70% of the data read/write rates available. [3.2.1.13.2-F, FCF-SPEC-xxx]
40	After SAR deployment, the volatile memory of all IOP single board computers and associated circuit boards shall be sized so the information required to perform the basis experiments as specified in FCF-DOC-002, does not exceed 65% of the bytes available and 80% of the data read/write rates available. [3.2.1.13.2-G, FCF-SPEC-xxx]
50	Prior to SAR deployment, the non-volatile memory of all IOP single board computers and associated circuit boards shall be sized so the information required to perform the basis experiments as specified in FCF-DOC-002, does not exceed 50% of the bytes available and 70% of the data read/write rates available. [3.2.1.13.2-H, FCF-SPEC-xxx]
60	After SAR deployment, the non-volatile memory of all IOP single board computers and associated circuit boards shall be sized so the information required to perform the basis experiments as specified in FCF-DOC-002, does not exceed 80% of the bytes available and 70% of the data read/write rates available. [3.2.1.13.2-I, FCF-SPEC-xxx]
70	Prior to SAR deployment, the IOP mass storage shall be sized so the information required to perform the basis experiments as specified in FCF-DOC-002, does not exceed 50% of the bytes available and 70% of the data read/write rates available. To meet this requirement it shall be assumed that no data can be offloaded from the mass storage during the conduct of the experiment (i.e., all information generated and sent to the mass storage must be retained). [3.2.1.13.2-J, FCF-SPEC-xxx]
80	After the SAR is deployed, the IOP mass storage shall be sized so the information required to perform the basis experiments as specified in FCF-DOC-002, does not exceed 80% of the bytes available and 70% of the data read/write rates available. To meet this requirement it shall be assumed that no data can be offloaded

	from the mass storage during the conduct of the experiment (i.e., all information generated and sent to the mass storage must be retained). [3.2.1.13.2-K, FCF-SPEC-xxx]

3.10.3 Computer Software Requirements

The IOP HRDL CSCI shall use the following computer software and their associated documentation references:

Requirement Id	Requirement Description
10	VxWorks Real Time Operating System version 5.4 . • VxWorks Programmer's Guide • VxWorks Network Programmer's Guide • VxWorks Reference Manual
20	DY4 Board Support Package
30	GNU C++ Compiler debugger, and associated utilities • GNU Make User's Guide • GNU User's Toolkit • GDB User's Guide
40	Tornado 2.0 Integrated Development Environment • Tornado Getting Started Guide • Tornado User's Guide • Tornado API Programmer's Guide • Tornado API Reference

3.10.4 Computer Communications Requirements

Requirement Id	Requirement Description
10	The IOP shall provide a data bus (Ethernet) between all FCF racks with a theoretical bi-directional data transfer rate of at least 100 Mbits/sec. [3.2.1.10, FCF-SPEC-xxx]
20	The IOP HRDL Processor CSCI shall be capable of data transfer rates to the ISS High Rate Data Link (HRDL) of up to the maximum rate of the HRDL. [3.7.1.3.2-I, 3.7.2.3.2-I, 3.7.3.3.3-E, FCF-SPEC-0001]

3.11 SOFTWARE QUALITY FACTORS

Refer to FCF Software Requirements Document, FCF-REQ-0063. Section 3.11 Software Quality Factors.

3.12 DESIGN AND IMPLEMENTATION CONSTRAINTS

Requirement Id	Requirement Description
10	The IOP software shall be an object oriented design produced using the Unified Process and documented with the Unified Modeling Language (UML). The application shall be written in C++ and/or JAVA, with the exception of COTS software and software classified as time critical. [3.2.1.13.2-C, FCF-SPEC-xxx] [3.4.2-C, FCF-SPEC-0001]
20	IOP software shall be modularized separately from PI specific hardware. [3.2.1.13.2-B, FCF-SPEC-xxx]
30	The IOP software shall be designed to facilitate migration for programs from systems supporting IOP development. [3.2.1.13.3-A, FCF-SPEC-xxx] [3.4.3-A, FCF-SPEC-0001
40	IOP software shall be designed to facilitate migration of programs to upgraded hardware and firmware. [3.2.1.13.3-B, FCF-SPEC-xxx] [3.4.3-B, FCF-SPEC-0001
50	The IOP shall use common data acquisition, data analysis, control, and power distribution components, and the maintenance and repair procedures for these components shall be common between IOPs in each Flight Segment rack. [3.2.1.16, FCF-SPEC-xxx] [3.8.2.4, FCF-SPEC-0001]
60	The IOP design shall allow for any IOP to be placed in any rack and operate without changes to the Flight Segment, IOP internal parts or software load. This includes the ability to remove one from a rack and install it in place of one in another rack. [3.2.1.17, FCF-SPEC-xxx] [3.8.2.6, FCF-SPEC-0001]
70	The IOP design shall allow for any IOP to be placed in any rack and operate without changes to the Flight Segment, IOP internal parts or software load. This includes the ability to remove one from a rack and install it in place of one in another rack. [3.2.1.17, FCF-SPEC-xxx] [3.8.2.6, FCF-SPEC-0001]
80	Any Flight Segment ORU or component within an ORU that performs the same function and has similar performance requirements as an ORU or component in another ORU shall be of identical design. Similar performance is defined as one ORU or component being able to meet the performance of the other within the same resources. This requirement implies a possible common design for items including, but not limited to the

	Input/Output Package (IOPs), racks, optics bench to rack interfaces, rack closures (doors), Environmental Control Subsystem (ECS) elements, Rack Maintenance Switch Assemblies (RMSAs), Common Video Interface Transmitter (CVIT) boards, HRDL interface boards, optical diagnostic packages, cameras, light sources, image processing equipment, and smoke detectors.
90	The Flight and Ground Segment software shall be modularized so that mission specific code, sequences and parameters can be changed without reloading non-mission specific code, sequences and parameters. [3.4.2-B, FCF-SPEC-0001]
100	TBD – Whether 3.4.2-E-L are applicable.

3.13 PERSONNEL-RELATED REQUIREMENTS

There are no personnel-related requirements.

3.14 TRAINING-RELATED REQUIREMENTS

There are no training-related requirements.

3.15 LOGISTICS-RELATED REQUIREMENTS

See the Software Requirements Document, FCF-REQ-0063, section 3.15. FCF-REQ-0063.

Reconfiguration of the Flight Segment activities shall be capable of being accomplished with the racks in their installed position.

3.16 OTHER REQUIREMENTS

There are no other requirements.

3.17 PACKAGING REQUIREMENTS

There are no packaging requirements.

3.18 PRECEDENCE AND CRITICALITY OF REQUIREMENTS

TBD

4.0 QUALIFICATION PROVISIONS

Verification Method TBD

Entry #	Req't	Verification Method					Verification Requirement
		N	I	A	T	D	
3.1 REQUIRED STATES AND MODES	10						
3.2 CSCI CAPABILITY REQUIREMENTS	NA						
3.2.1 Data Management	10						
3.2.1 Data Management	20						
3.2.1 Data Management	30						
3.2.1 Data Management	40						
3.2.1 Data Management	50						
3.2.1 Data Management	60						
3.2.2 Reconfig & Maintenance	10						
3.2.2 Reconfig & Maintenance	20						
3.2.2 Reconfig & Maintenance	30						

Entry #	Req't	Verification Method					Verification Requirement
3.2.2 Reconfig & Maintenance	40						
3.2.2 Reconfig & Maintenance	50						
3.2.2 Reconfig & Maintenance	60						
3.2.2 Reconfig & Maintenance	70						
3.2.3 PI Related	10						
3.2.3 PI Related	20						
3.2.3 PI Related	30						
3.3 CSCI EXTERNAL INTERFACE REQUIREMENTS	10						
3.3.2.1 ISS Fiber Optic HRDL I/F	NA						
3.3.2.1.1 Command and Telemetry	10						
3.3.2.1.2 Data Formats	10						
3.3.2.1.2 Data Formats	20						
3.3.2.1.2 Data Formats	30						
3.3.2.1.2 Data Formats	40						
3.3.2.1.2 Data Formats	50						
3.3.2.1.2 Data Formats	60						
3.3.2.1.2 Data Formats	70						
3.3.2.1.2 Data Formats	80						
3.3.2.1.2 Data Formats	90						
3.3.2.1.2 Data Formats	100						
3.3.2.1.2 Data Formats	110						
3.3.2.1.3 Data Link	10						
3.3.2.1.3 Data Link	20						
3.3.2.1.3 Data Link	30						
3.3.2.1.3 Data Link	40						
3.3.2.1.3 Data Link	50						
3.3.2.1.3 Data Link	60						
3.3.2.1.3 Data Link	70						
3.3.2.1.3 Data Link	80						
3.3.2.1.3 Data Link	90						
3.3.2.1.3 Data Link	100						
3.3.2.1.3 Data Link	110						
3.3.2.1.3 Data Link	120						
3.4 CSCI INTERNAL INTERFACE REQUIREMENTS	10						
3.4 CSCI INTERNAL INTERFACE REQUIREMENTS	20						
3.5 CSCI INTERNAL DATA REQUIREMENTS	10						
3.5 CSCI INTERNAL DATA REQUIREMENTS	20						
3.6 ADAPTATION REQUIREMENTS	NA						
3.7 SAFETY REQUIREMENTS	NA						
3.8 SEQURITY AND PRIVACY REQUIREMENTS	10						
3.9 CSCI ENVIRONMENT REQUIREMENTS	10						
3.10 COMPUTER RESOURCE REQUIREMENTS	NA						
3.10.1 Computer Hardware	10						

Entry #	Req't	Verification Method					Verification Requirement
Requirements							
3.10.1 Computer Hardware Requirements	20						
3.10.2 Computer Hardware Resource Utilization Requirements	10						
3.10.2 Computer Hardware Resource Utilization Requirements	20						
3.10.2 Computer Hardware Resource Utilization Requirements	30						
3.10.2 Computer Hardware Resource Utilization Requirements	40						
3.10.2 Computer Hardware Resource Utilization Requirements	50						
3.10.2 Computer Hardware Resource Utilization Requirements	60						
3.10.2 Computer Hardware Resource Utilization Requirements	70						
3.10.2 Computer Hardware Resource Utilization Requirements	80						
3.10.3 Computer Software Requirements	10						
3.10.3 Computer Software Requirements	20						
3.10.3 Computer Software Requirements	30						
3.10.3 Computer Software Requirements	40						
3.10.4 Computer Communications Requirements	10						
3.10.4 Computer Communications Requirements	20						
3.11 SOFTWARE QUALITY FACTORS	NA						See FCF-REQ-0063 Section 3.11
3.12 DESIGN AND IMPLEMENTATION CONSTRAINTS	10						
3.12 DESIGN AND IMPLEMENTATION CONSTRAINTS	20						
3.12 DESIGN AND IMPLEMENTATION CONSTRAINTS	30						
3.12 DESIGN AND IMPLEMENTATION CONSTRAINTS	40						
3.12 DESIGN AND IMPLEMENTATION CONSTRAINTS	50						
3.12 DESIGN AND IMPLEMENTATION CONSTRAINTS	60						
3.12 DESIGN AND IMPLEMENTATION CONSTRAINTS	70						
3.12 DESIGN AND IMPLEMENTATION CONSTRAINTS	80						
3.12 DESIGN AND IMPLEMENTATION CONSTRAINTS	90						
3.12 DESIGN AND IMPLEMENTATION CONSTRAINTS	100						
3.13 PERSONNEL-RELATED REQUIREMENTS	NA						

Entry #	Req't	Verification Method					Verification Requirement
3.14 TRAINING-RELATED REQUIREMENTS	NA						
3.15 LOGISTICS-RELATED REQUIREMENTS							See FCF-REQ-0063 Section 3.15
3.16 OTHER REQUIREMENTS	NA						
3.17 PACKAGING REQUIREMENTS	NA						
3.18 PRECEDENCE AND CRITICALITY OF REQUIREMENTS	TBD						

Table 4-1 Qualification Provisions

5.0 REQUIREMENTS TRACEABILITY

Traceability is provided by annotations for each requirement in section 3.

6.0 NOTES

7.0 ABBREVIATIONS AND ACRONYMS

ARIS	Active Rack Isolation System
BC	Bus Controller
CCS	Calendar Segmented Time Code
CCSDS	Consultative Committee for Space Data Systems
CIR	Combustion Integrated Rack
CMM	Capability Maturity Model
CSCI	Computer Software Configuration Item
CUC	Unsegmented Time Code
CVIT	Common Video Interface Transmitter
DCR	Document Change Request
EPCU	Electrical Power Control Unit
EWT	Embedded Web Technology
FCF	Fluids and Combustion Facility
FDC	Federal Data Corporation
FIR	Fluids Integrated Rack
FOMA	Fuel Oxidizer and Management Assembly
GRC	Glenn Research Center
HRDL	High Rate Data Link
HRFM	High Rate Frame Multiplexer
ICD	Interface Control Document
IOP	Input/Output Package

IPP	Image Processing Package
IRS	Interface Requirements Specifications
ISPR	International Standard Payload Rack
ISS	International Space Station
LAN	Local Area Network
LRDL	Low Rate Data Link
MDM	Multiplexer Demultiplexer
MRDL	Medium Rate Data Link
NRZI	Non Return to Zero Event
NVR	No Verification Required
ORU	Orbital Replacement Unit
PFM	Pulse Frequency Modulation
PRCU	Payload Rack Checkout Unit
RT	Remote Terminal
SAMS	Space Acceleration and Measurement System
SAR	Shared Accommodations Rack
SEI	Software Engineering Institute
SEPO	Software Engineering Process Office
SRS	Software Requirements Specification
SSC	Station Support Computer
SSP	Space Station Procedure
STEP	Suitcase Test Environment for Payloads
TBD	To Be Determined

TSC	Telescience Center
US Lab	United States Laboratory Module

APPENDIX A USE-CASE DIAGRAMS

APPENDIX B TBD'S

B.1 Scope.

This appendix lists all items in this document that need to be determined (TBD).

B.2 List of TBD's.

Table 7-1TBD's

TBD Number	Description	Document Paragraph

DOCUMENT CHANGE REQUEST (DCR)

Document Title:	Tracking Number:
Name of Submitting Organization:	
Organization Contact:	Phone:
Mailing Address:	
Short Title:	Date:
Change Location: (use section #, figure #, table #, etc.)	
Proposed change:	
Rational for Change:	
Note: For the Software Engineering Process Office (SEPO) to take appropriate action on a change request, please provide a clear description of the recommended change along with supporting rationale. Send to: Federal Data Corporation (FDC), SEPO, 7501 Greenway Center Drive, Suite 1200, Greenbelt, MD 20770 or Fax to: (301) 441-1012. *FDC PROPRIETARY*	